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DEPARTMENT OF ECONOMICS
RESEARCH MEMORANDUM

RATIONING IN OPEN ECONOMY AND DYNAMIC
MACROECONOMICS: A SURVEY

Frederick van der Ploeg

3305

FEW 269

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RATIONING IN OPEN ECONOMY AND DYNAMIC MACROECONOMICS: A SURVEY

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ABSTRACT

A survey of rationing in micro theories of macroeconomics is presented. The survey starts with a closed economy with money and inventories, which consists of a representative household, a firm and government. After a discussion of the notional demands and supplies and the properties of the Walrasian equilibrium, a discussion of the effective demands and supplies leads to an analysis of the four regimes (Keynesian unemployment, classical unemployment, repressed inflation and underconsumption). A fiscal and monetary contraction decreases sales and employment when there is Keynesian unemployment, but is expansionary (neutral) when there is repressed inflation (classical unemployment). The survey continues with an analysis of the effects of rationing in a small open economy. It considers the one-sector model and a model with a traded and a non-traded sector. The latter model is used to discuss the effects of an oil discovery on the Gulf countries and an Latin American countries. The survey ends up with a discussion of rationing in dynamic economies, which leads to an analysis of the effects of expectations about future constraints on current regimes and to a discussion of "boot-strap" equilibria.

April 1987

* The author is Director of the Network for Quantitative Economics. This paper is a brief and eclectic survey of rationing models of closed one-period and two-period economies and of small open economies. It contains no significant new material. The author is grateful to Prof. Dr. Theo van de Klundert for his constructive comments on an earlier version of this survey.

1. Introduction

With the revival of classical macroeconomics induced by the New Classical School of Macroeconomics, market clearing has become the predominant mode of analysis. Within such a framework there is no role for fiscal or monetary policy, since the level of unemployment in the economy will always be at its natural rate unless there are unanticipated shocks. The Walrasian auctioneer revises prices upwards (downwards) when there is an excess demand (supply) for a particular commodity and continues until the Walrasian equilibrium is attained. No trading takes place until the Walrasian equilibrium is attained. As there are no externalities or informational failures, the Walrasian equilibrium is efficient and there is no role for government actions. The market-clearing approach to macroeconomics is particularly popular in the U.S. and its revival may have been responsible for the recent *laissez-faire* policies adopted by most Western governments. Since the market-clearing approach abstracts from involuntary unemployment, it cannot address the major policy issue Western countries have been wrestling with for the last ten years. The neo-classical synthesis, discussed in most textbooks, assumes informational asymmetries in the sense that firms know aggregate prices yet workers base wage formation on expected prices and adapt their expectations in a sluggish manner. The neo-Keynesian synthesis gives a transient role for demand management, but does not give a micro foundation of Keynesian unemployment. Hence, recently the fixed-price approach to macroeconomics has become, particularly in Europe, very popular. The fixed-price or rationing approach can be viewed as the opposite extreme of the Walrasian flex-price approach and is much more relevant in the short run. The flex-price approach is usually associated with the Walrasian auctioneer who revises prices upwards (downwards) when there is an excess demand for (supply of) a particular commodity. This is not a very satisfactory approach, as no trading is assumed to take place until the Walrasian equilibrium has been attained, and therefore the analysis of the fix-price approach is of great practical importance.

When one recognizes the fact that prices may fail to adjust to their Walrasian equilibrium levels, it is the adjustment of quantities that leads to a fixed-price, rationing or temporary equilibrium. In such a situation the actual amount transacted is determined by the "short-side"

of the market and the "long side" gets rationed. An important feature is that agents who are rationed in one market will recalculate their actions in other markets. For example, Patinkin (1965) argued that, when there is an excess supply of goods, firms' demand for labour will fall. Clower (1965) argues that, when there is involuntary unemployment, private demand for goods will be lower. Clower's dual decision hypothesis generalizes the analysis by distinguishing between the original notional and the recalculated effective demands and supplies. The nature of the resulting temporary equilibria depends on the values taken by the sticky prices. Naturally, such quantity signals imply informational failures so that fixed-price economies need not be efficient. The models of closed economies that concentrate on disequilibria in labour and product markets (e.g., Barro and Grossman, 1976; Malinvaud, 1977; Muellbauer and Portes, 1978; Bénassy, 1980) result in four possible regimes: Keynesian unemployment, classical unemployment, repressed inflation and underconsumption. To obtain the second and fourth regime it is important to allow for the buffer stock role of both money balances and inventories. The first regime provides a micro foundation of Keynes' concept of involuntary unemployment. Obviously, the appropriate nature of the policy actions of the government depend crucially on the nature of the prevailing regime. Barro and Grossman (1976) also extend the basic model by allowing for markets in fixed investment and financial assets other than money. Some refer to this approach to macroeconomics as the disequilibrium approach, but we prefer to refer to it as the rationing approach as all agents are on their effective demand and supply schedules, all trade is voluntary and therefore the economy is in (temporary) equilibrium. Most of these macroeconomic models with rationing imply that there cannot be both rationed sellers and rationed buyers, which is inconsistent with the presence of both unfilled vacancies and unemployment. To relax this undesirable feature, one needs to allow for a variety of local labour markets (e.g., Muellbauer, 1978; Kooiman, 1984). Honkapohja (1979) and Malinvaud (1980) extend rationing models of closed economies with wage and price dynamics.

A closed economy may be relevant for the world as a whole or for the U.S., but most countries resemble a small open economy much more closely. Dixit (1978) discusses a small open economy with one sector. In such a context rationing of the goods market is impossible, because excess

demand (or supply) for home goods can be met by imports from (exports to) the rest of the world, and therefore only the labour market can be in disequilibrium. Neary (1980) extends the analysis to allow for a small open economy with a traded ("exposed") and a non-traded goods ("sheltered") sector, i.e., for the dependent economy model of Salter (1959). Despite the fact that there are no inventories and the demand for or supply of traded goods can never be rationed, the four regimes of the Barro-Grossman-Malinvaud analysis reappear. For example, underconsumption corresponds to an excess supply of non-traded goods and an excess demand for labour. Van Wijnbergen (1984) applies the dependent economy model to analyse the effects of an oil bonanza. The Gulf countries have a relatively high share of imported goods in their consumption basket and are therefore more likely to end up in a regime of regressed inflation. On the other hand, the Latin American oil producers have (due to various import barriers) a relatively low share of imported goods and are therefore more likely to end up in a regime of classical unemployment. This latter possibility is referred to as the "Dutch Disease". Van Wijnbergen (1985) considers the intertemporal disequilibrium effects of an oil bonanza and Neary and van Wijnbergen (1986) give a general survey of the "Dutch Disease". More extended surveys of rationing in open economies are Cuddington, Johansson and Lofgren (1984) and Neary (1986). Examples of two-country rationing models are presented in Owen (1985) and Rankin (1987b).

Another interesting extension of the Barro-Grossman-Malinvaud analysis is to consider dynamic, closed economies. Neary and Stiglitz (1983) use a two-period rationing model of a closed economy to analyse the effects of expectations about future constraints on current regimes. They find that this leads to "boot-strap" equilibria, that is households' (firms') expectations of future constraints on their ability to sell labour (goods) make it more likely that they face a sales constraint in the current period. They also consider rational constraint expectations and show that, when Keynesian unemployment prevails in the current period, the employment multiplier of government spending is greater with rational than with static expectations of Keynesian unemployment (and greater still than with Walrasian expectations). This is an important result, because it shows that the policy neutrality propositions of the New Classical School

of Macroeconomics (e.g. Sargent and Wallace, 1975) rely crucially on their assumption that prices and wages move instantaneously to clear all goods and labour markets and do not rely on their assumption of rational expectations. These policy neutrality propositions must therefore be treated as a theoretical curiosum. Blanchard and Sachs (1982) formulate a continuous-time rationing model of a closed economy with infinitely-lived agents and capital accumulation and use a "multiple shooting" algorithm, for the dynamic simulation of perfect-foresight models, to consider the effects of unanticipated and anticipated policies. Van de Klundert and Peters (1986) extend their analysis to answer questions about tax incidence in the various regimes.

Section 2 surveys the effects of rationing in a closed economy and discusses the effects of fiscal and monetary policy. Section 3 discusses rationing in small open economies (with one sector and with two sectors) and analyses the effects of an oil bonanza on the dependent economy. Section 4 considers the effects of constraint expectations in an intertemporal model. Section 5 concludes the survey.

2. Rationing and macroeconomic theory¹⁾

2.1. Notional demands and supplies

We assume that there is a representative household, who consumes goods, leisure and real money balances, a representative firm, who demands labour and supplies goods, and a government, which demands goods and prints money to finance these goods. Agents cannot influence wages or prices. The asset menu consists of only money, so that there are no interest-bearing assets. The notional demands and supplies are those demands and supplies which prevail when agents are not rationed, that is when households can buy all the goods they wish and sell as much labour as they wish and when firms can hire as much labour as they want and sell as much goods as they want. The government is assumed never to be rationed in its demand for goods. The notional demands and supplies will be indicated by superscripts d and s , respectively. Let us first consider the notional demands and supplies of households.

The households choose consumption (c), their supply of labour (l), and their holdings of real money balances (m) to maximize their utility, $U(c, l, m)$, subject to the household budget constraint (HBC), $m - m_0 = \pi_0 + w l - c$ where m_0 and π_0 denote initial holdings of real money balances and real profits are assumed to be distributed at the end of the previous period and w denotes the real wage. The maximum labour supply is unity. Since money is the only asset, savings lead to an increase in real money balances. Utility is an increasing function of consumption, leisure ($1-l$) and real money balances, and is concave in its arguments. Feenstra (1986) provides some justification, based on the transaction cost approach, for including real money balances in the utility function. It could be viewed as a proxy for future consumption possibilities (Dixit and Norman, 1980) and gives a simple theory of the demand for money. Bénassy (1982) gives an alternative justification function for putting money in the utility func-

1) Sections 2.1-2.5 are based on a lecture hand-out for the Master's course in Macroeconomics of the London School of Economics originally developed by Willem Buiter. The author is grateful to the course organised, Charles Bean, for permission to use some of this material.

tion. The first-order conditions²⁾ are: (i) the marginal rate of substitution between consumption and leisure should equal the real wage, $-U_l/U_m = w$; (ii) the marginal utility of consumption should equal the marginal utility of real money balances, $U_c = U_m$; and (iii) the HBC. We will assume that goods, leisure and real money balances are normal goods. A sufficient condition for this is that the utility function is weakly separable, say $U(.) = \alpha_1 \log(c) + \alpha_2 \log(1-l) + \alpha_3 \log(m)$, $\alpha_i \geq 0$, $\alpha_1 + \alpha_2 + \alpha_3 = 1$. It follows that:³⁾

$$c^d = C^d(w, m_0 + \pi_0 + w) = \alpha_1 (m_0 + \pi_0 + w) \quad (1)$$

$$l^s = L^s(w, m_0 + \pi_0 + w) = 1 - \alpha_2 (m_0 + \pi_0 + w)/w \quad (2)$$

$$m^d = M^d(w, m_0 + \pi_0 + w) = \alpha_3 (m_0 + \pi_0 + w) \quad (3)$$

where the explicit solutions are given for the case of Cobb-Douglas preferences. The question marks in (1) and (3) arise from the ambiguity due to the income effect and the substitution effect. When "income", that is initial holdings of real money balances, profits and full-employment wage income, increases, savings and consumption of goods and leisure increase. An increase in the real wage also increases the opportunity cost of leisure, so that the net effect of the real wage on leisure and the supply of labour is ambiguous. For Cobb-Douglas preferences, the substitution effect dominates.

Now consider the notional decisions of firms. Since we want to allow for the regime of underconsumption (excess demand for labour and excess supply of goods), we allow for a simple theory of inventory holdings (e.g., Muellbauer and Portes, 1978). Hence, firms choose their demand

2) The signs of the partial derivatives are given above the expressions.

3) The signs of the partial derivatives are given above the expressions.

for labour and their holdings of inventories (i) to maximize $\pi + V(f(l) - s + i_0)$ where s denotes sales of output and i_0 denotes the stock of inventories at the end of the previous period. Profits are defined as $\pi = s - wl$. The production function is $f(l)$ and satisfies $f'(l) > 0$ and $f''(l) < 0$. Due to the uncertainty firms face about price and wage outcomes (and possibly about ration levels and constraint regimes), firms attach a value to inventories at the end of the current period (i), $V(i)$ where $i = f(l) - s + i_0$. This value function satisfies $V'(i) > 0$ and $V''(i) < 0$. The first-order conditions are that the marginal value of inventories is unity, $V'(i) = 1$, and that the marginal product of labour equals the real wage, hence

$$l^d = L^d(w), \quad L^{d'} = 1/f'' < 0 \quad (4)$$

and

$$s^s = i_0 + f(L^d(w)) = S^s(w, i_0), \quad S_1^s = f'/f'' < 0, \quad S_2^s = 1. \quad (5)$$

Since the marginal productivity of labour diminishes, one obtains a standard downward-sloping labour-demand schedule. The special case of no inventories yields $s^s = f(L^d(w)) = S^s(w)$.

The government budget constraint (GBC) follows from the HBC and GME and is given by $(m - m_0) + (\pi + \pi_0) = g$. Hence, the net acquisition of financial assets by the private sector (households and firms) equals total money creation and must match the government deficit.

2.2. Walrasian equilibrium

Before we discuss disequilibrium in product and labour markets, a brief discussion of Walrasian equilibrium (WE) will be useful. In WE the adjustment of prices and wages ensures that all markets clear and therefore all agents are on their notional demand and supply curves. The labour market clears when $L^s(w, m_0 + \pi_0 + w) = L^d(w)$ holds and the goods market clears when $S^s(w, i_0) = C^d(w, m_0 + \pi_0 + w) + g$ holds, where g denotes the level of real government spending. Since $m_0 = M_0/P$ where M_0 is the given stock

of nominal money balances at the end of the previous period and P is the nominal price level, labour market equilibrium (LME) and goods market equilibrium (GME) give two loci in w - P space. For the case of Cobb-Douglas preferences, the LME locus slopes downwards, since a high real wage induces an incipient excess supply of labour which is choked off by a low price level as this boosts real "income" and the demand for leisure, and the GME locus slopes upwards, since a low real wage induces an excess supply of goods which needs to be choked off by a low price level as this boosts real non-wage "income" and thus the demand for goods. The intersection of the two loci gives the WE (see Figure 1).

An increase in government spending leads to an incipient excess demand for goods, which is choked off by a reduction in real "income" and consumption induced by an increase in the price level. This leads to an incipient excess supply of labour, which is choked off by a fall in the real wage. The net effect is an increase in employment. The WE shifts from W to W' .

An increase in fiat money (M_0) also shifts out the LME locus, so that the price level increases and the real wage either falls or increases. The reason is that the associated increase in wealth cuts labour supply and therefore the real wage has to rise in order to restore LME. Hence, the effect on employment is ambiguous.

2.3. Effective demands and supplies

Effective demands and supplies are relevant when agents are rationed, which may occur when wages and prices are fixed, and are contingent on rations in all other markets (Bénassy, 1975).

When households are constrained on the labour market, $l^s > l^d$, the effective labour supply is given by the demand for labour, $l = l^d$, and effective demand for goods ($\tilde{c}^d$) follows from the fact that the marginal rate of substitution between goods and real money balances evaluated at

the rationed level of labour supply, is unity, $U_c(\tilde{c}^d, l, m_0 + \pi_0 + wl - \tilde{c}^d) = U_m(\tilde{c}^d, l, m_0 + \pi_0 + wl - \tilde{c}^d)$ and therefore⁴⁾

$$\tilde{c}^d = \tilde{c}^d(m_0 + \pi_0 + wl, l) = \alpha_1(m_0 + \pi_0 + wl)/(1 - \alpha_2). \quad (6)$$

The spill-over effect of disequilibrium in the labour market on the demand for goods means that households cannot work as much as they wish and therefore their effective demand for goods is less. When households are constrained on the goods market, $c^d > c^s = s^s - g$, the effective demand for goods is constrained by the supply of goods, $c = c^s$, and the effective supply of labour ($\tilde{l}^s$) follows from the fact that the marginal rate of substitution between real money balances and leisure, evaluated at the rationed level of the demand for goods, should equal the real wage, $U_l(c, l, m_0 + \pi_0 + wl - c) = -w U_m(c, l, m_0 + \pi_0 + wl - c)$ and therefore

$$\tilde{l}^s = \tilde{l}^s(m_0 + \pi_0 - c, c, w) = [\alpha_3 - \alpha_2(m_0 + \pi_0 - c)/w]/(1 - \alpha_1). \quad (7)$$

The spill-over effect of disequilibrium in the product market on the supply of labour implies that, when households cannot purchase all the goods they wish, their effective supply of labour is less. When households are constrained on both markets, $c^d > c^s$ and $l^s > l^d$, the rule of the short side of the market says that the effective quantities are given by $c = s^s - g$ and $l = l^d$.

When firms are constrained on the labour market, $l^d > l^s$, they cannot get hold of enough workers and therefore $l = l^s$ and their effective supply of goods ($\tilde{s}^s$) is less. The effective supply of goods follows from $V'(f(l) + i^0 - \tilde{s}^s) = 1$, so that

4) It is easily shown that $\tilde{c}_m^d = (U_{mm} - U_{cm})/(U_{cc} - 2U_{cm} + U_{mm})$ and $\tilde{c}_l^d = (U_{ml} - U_{cl})/(U_{cc} - 2U_{cm} + U_{mm})$. Hence, for separable (e.g., Cobb-Douglas) preferences, $\tilde{c}_m^d > 0$. In general $\tilde{c}_l^d > 0$ and, if goods and money balances are coeprant commodities, $\tilde{c}_m^d > 0$.

$$\tilde{s}^S = \tilde{S}^S(i_0^+, l), \tilde{S}_1^S = 1, \tilde{S}_2^S = f'(l). \quad (8)$$

For the special case of no inventories, $\tilde{s}^S = f(l)$. When firms are constrained on the goods market due to a lack of effective demand, $c^d + g < s^S$, the supply of goods is rationed, $s = c^d + g$, and therefore the effective demand for labour ($\tilde{l}^d$) is less. $\tilde{l}^d$ follows from $V'(f(\tilde{l}^d) + i_0 - s)f'(\tilde{l}^d) = w$, so that

$$\tilde{l}^d = \tilde{L}^d(s - i_0^-, w), L_1^d = \{f'[1 + (V'f''/V''(f'')^2)]\}^{-1} < 1/f'. \quad (9)$$

For the special case of no inventories, the demand for labour is determined by the effective demand for goods, $\tilde{l}^d = f^{-1}(s)$. When firms are constrained on both markets, $\tilde{l}^d > l^S$ and $\tilde{s}^d < s^S$, the effective quantities are $l = l^S$ and $s = s^d = c^d + g$.

2.4. The four regimes

It is clear that rationing implies that the GME and LME loci of Figure 1 are no longer valid, since disequilibrium in one market spills over into another market. Goods market equilibrium with an excess supply of labour (XSL) is given by

$$S^S(w, i_0^+) = \tilde{C}^d(m_0^+ + \pi_0^+ w, L^d(w)) + g. \quad (10)$$

The associated GME:XSL locus is steeper than the GME locus, because unemployment means that households have less income and consume less and consequently one needs lower prices ("Keynes" effect) to boost demand or higher real wages to attenuate supply. Goods market equilibrium when there is an excess demand for labour (XDL) is given by

$$\tilde{S}^S(i_0^+, L^S(w, m_0^+ + \pi_0^+ w)) = C^d(w, m_0^+ + \pi_0^+ w) + g. \quad (11)$$

Since firms are rationed in their demand for labour, they supply less goods and therefore the price level has to rise and thus erode wealth and reduce consumption demand and increase the supply of labour or the real

wage has to fall in order to restore GME. It follows that the GME:XDL locus is steeper than the GME locus.

Labour market equilibrium with an excess supply of goods (XSG) is given by

$$L^S(w, m_0 + \pi_0 + w) = \tilde{L}^d(C^d(w, m_0 + \pi_0 + w) + g - i_0, w). \quad (12)$$

Since firms are rationed in their sales of goods, their demand for labour falls and therefore the real wage must fall in order to restore LME. Hence, the LME:XSG locus is steeper than the LME locus. Labour market equilibrium with an excess demand for goods is given by

$$\tilde{L}^S(m_0 + \pi_0 - S^S(w, i_0) + g, S^S(w, i_0) - g, w) = L^d(w). \quad (13)$$

Now households cannot buy as many goods as they wish, so that labour supply falls and therefore the real wage has to rise in order to choke of the demand for labour and restore LME. Hence, the LME:XDG locus is steeper than the LME locus.

We are now ready to partition the w-P space in to four regimes:

CLASSICAL UNEMPLOYMENT (CU) - XDG, XSL;

KEYNESIAN UNEMPLOYMENT (KU) - XSG, XSL;

REPPRESSED INFLATION (RI) - XDG, XDL;

UNDERCONSUMPTION (UC) - XSG, XDL.

When there is no possibility of inventory holdings (e.g. Barro and Grossman, 1976; Malinvaud, 1977), the LME:XSG and GME:XDL loci coincide and the underconsumption regime disappears. The reason is that a lack of effective demand for goods and an excess demand for labour are impossible when there are no inventories. Similarly, the regime of classical unemployment disappears when there is no money or other store of value.

2.5. Effectiveness of fiscal and monetary policy in each of the regimes

In the regime of classical unemployment households are rationed in both markets, so that $s = S^S(w, i_0)$ and $l = L^d(w)$. Hence, neither fiscal nor monetary policy has real effects.

In the regime of Keynesian unemployment there is generalized excess supply, so that GME is given by $s = \tilde{c}^d(m_0 + \pi_0 + w\lambda, \lambda) + g$ and LME is given by $\lambda = \tilde{L}^d(s - i_0, w)$. Solving for s and λ yields:

$$\begin{bmatrix} ds \\ d\lambda \end{bmatrix}_{KU} = \frac{1}{\Delta} \begin{bmatrix} 1 & \tilde{c}_1^d & \lambda \tilde{c}_1^d - \tilde{L}_2^d(w\tilde{c}_1^d + \tilde{c}_2^d) \\ \tilde{L}_1^d & \tilde{L}_1^d \tilde{c}_1^d & \lambda \tilde{L}_1^d \tilde{c}_1^d + \tilde{L}_2^d \end{bmatrix} \begin{bmatrix} dg \\ dm_0 \\ dw \end{bmatrix} \quad (14)$$

where $\Delta = 1 - \tilde{L}_1^d(w\tilde{c}_1^d + \tilde{c}_2^d) > 0$ ⁵⁾. It follows that an increase in real government spending, an increase in the nominal money supply and a fall in the price level increase aggregate demand and therefore increase sales and employment. An increase in the real wage increases real income and therefore increases consumption, sales and employment. However, it also increases the cost of labour and therefore cuts employment. The net effect of the real wage on employment in the KU regime is therefore ambiguous. However, in principle it is possible that the real wage moves pro-cyclically.

In the regime of repressed inflation there is generalized excess demand, so that GME is given by $s = \tilde{S}^s(i_0, \lambda)$ and LME by $\lambda = \tilde{L}^s(m_0 + \pi_0 - s + g, s - g, w)$. It follows that

$$\begin{bmatrix} ds \\ d\lambda \end{bmatrix}_{RI} = \frac{1}{\Delta'} \begin{bmatrix} \tilde{S}_2^s(\tilde{L}_1^s - \tilde{L}_2^s) & \tilde{L}_1^s \tilde{S}_2^s & \tilde{S}_2^s \tilde{L}_3^s \\ \tilde{L}_1^s - \tilde{L}_2^s & \tilde{L}_1^s & \tilde{L}_3^s \end{bmatrix} \begin{bmatrix} dg \\ dm_0 \\ dw \end{bmatrix} \quad (15)$$

where $\Delta' = 1 - \tilde{S}_2^s(\tilde{L}_2^s - \tilde{L}_1^s)$ is assumed to be positive. An increase in real government spending worsens the rationing of the demand for goods of private agents, hence there is less incentive for households to supply labour and consequently firms supply even less goods. The expression for $(ds/dg)_{RI} < 0$ is called the supply multiplier (Barro and Grossman, 1976).

5) Note that with XSL and XSG $w < f' < 1/\tilde{L}_1^d$ must hold, so that $w\tilde{L}_1^d \tilde{c}_1^d < \tilde{c}_1^d < 1$ and (definitely for the case of separable preferences) $\Delta > 0$. The condition that $\Delta > 0$ is analogous to the Keynesian condition that the "marginal propensity to consume" is less than unity.

An increase in the nominal money supply, M_0 , or a fall in the price level increases real income and therefore reduces the supply of labour and consequently reduces the sales of goods. An increase in the real wage reduces the demand for leisure, so that the supply of labour and therefore sales increase. Repressed inflation is particularly relevant in the Eastern European economies.

Finally, in the regime of underconsumption firms are rationed in their sales of goods and in their purchases of labour, so that GME is given by $s = C^d(w, m_0 + \pi_0 + w) + g$ and LME by $l = L^s(w, m_0 + \pi_0 + w)$. It follows that an increase in government spending increases sales one-for-one, i.e. there are no "multiplier" effects, and does not affect employment. An increase in real money balances increases real income and therefore increases sales and reduces the labour supply, $(ds/dm_0)_{UC} = C_2^d > 0$ and $(dl/dm_0)_{UC} = L_2^s < 0$. An increase in the real wage increases real income and therefore increases sales and cuts the supply of labour. However, it also increases the opportunity cost of leisure and therefore increases employment. The net effect on employment is ambiguous, but for Cobb-Douglas preferences it is positive (see expression (2)).

2.6. Wage and price dynamics

So far, the analysis assumed fixed wages and prices. It is interesting to ask the question how wages and prices adjust towards the Walrasian equilibrium over time (e.g., Honkapohja, 1979; Malinvaud, 1980). One possibility is to assume that real wages rise (decline) when there is an excessive effective demand for (supply of) labour (i.e., "real wage rigidity") and that prices rise (fall) when there is an excess effective demand for (supply of) goods. In a KU or UC regime there is XSG, so that $\hat{w} = \dot{w}/w = \lambda_L(\tilde{l}^d - l^s)$, but in a CU- or RI-regime there is XDG and therefore $\hat{w} = \lambda(\tilde{l}^d - l^s)$ with $\lambda_L > 0$. In a CU- or KU-regime there is XSL and $\hat{P} = \dot{P}/P = \lambda_G(\tilde{c}^d + g - s^s)$, but in a RI- or UC-regime there is XDG and therefore $\hat{P} = \lambda_G(\tilde{c}^d + g - \tilde{s}^s)$ with $\lambda_G > 0$. The associated phase-arrows are given in Figure 2 and demonstrate that the real wage-price adjustment is a convergent (monotonic or cyclical) process. If the initial position is one of Keynesian unemployment, both real wages and prices fall. The fall in real wages chokes off the excess supply of labour and the effective supply of goods.

The fall in prices boosts real money balances and wealth, which increases the effective demand for goods and labour and cuts the supply of labour. This process eventually moves the economy in to a regime of underconsumption, where the real wage starts rising and thus increasing the demand for goods and choking off the excess demand for labour. The falling prices also tend to create an excess demand for goods, so that eventually the economy moves in to a regime of repressed inflation. The cyclical adjustment carries on until the Walrasian equilibrium is reached. A formal proof is complicated by the fact that the Jacobian of the two-dimensional dynamic system is not continuous, so that the simple local stability condition of a negative trace and a positive determinant cannot be applied. Instead, one has to use more sophisticated mathematical techniques (e.g., Ito, 1979; van den Heuvel, 1983; Honkapohja and Ito, 1983). In certain cases, it is even possible to have cycles between the regimes (Blad and Zeeman, 1982) or catastrophe (Madden, 1982).

One could argue that nominal wage rigidity is more realistic than real wage rigidity and that downward stickyness of the nominal wage is important. In that case, it is not difficult to see that Keynesian unemployment is likely to last rather longer than classical unemployment (e.g., Malinvaud, 1980).

One of the problems with studies of the dynamic adjustment of wages and prices so far is that they ignore the dynamics of inventories (e.g., Honkapohja and Ito, 1980), savings and expectations about future constraints (see Section 4) and that they ignore the intertemporal government budget constraint (e.g., Rankin, 1987a for a closed economy; and van Wijnbergen, 1986 for a small open economy). Future studies of rationing in closed economies should consider the interactions between wage-price dynamics, wealth dynamics, expectational dynamics, and the dynamics of the government budget constraint. Such consideration might also lead to an analysis of stochastic quantity rationing (e.g., Honkapohja and Ito, 1985; Gerard-Varet, Jordan and Kirman, 1986).

3. Rationing in small open economies

3.1. A one-sector model

For policy purposes it is important to consider the implications of rationing for a small open economy. Dixit (1978) discusses the effects of rationing in a one-sector model of a small open economy with no inventories, immobile labour, tradeable goods, prices determined on the world market (purchasing power parity, $P = P^* E$ where P^* is the world price level and E is the nominal exchange rate), and fixed exchange rates. In fact, rationing in such an open economy is much simpler than in a closed economy. Any effective excess demand for or supply of goods is met by importing goods from or exporting goods to the rest of the world. Hence, there can never be any spill-over effects from the goods market on to the labour market and thus whether unemployment or overemployment prevails depends entirely on whether the real wage is too high or too low.

The balance of trade (net exports, b) follows from the absorption approach, that is the excess of production over absorptions. When there is an excess supply of labour, it is given by

$$b = f(L^d(w)) - \tilde{C}^d(m_0 + \pi_0 + w L^d(w), L^d(w)) - g, \quad (16)$$

and when firms are rationed, it is given by

$$b = f(L^s(w, m_0 + \pi_0 + w)) - C^d(w, m_0 + \pi_0 + w) - g. \quad (16')$$

We assume that there is real wage rigidity, so that w is fixed in the short run irrespective of whether exchange rates float or are pegged.

Figure 3 presents the four possible outcomes and has some similarities with the familiar Mundell-Swan diagram. In the short run the economy may experience a trade surplus (or deficit), but in the long run this leads in the absence of sterilisation to an increase (decrease) in foreign reserves, the money supply and wealth, and thus to a downward (upward) shift of the effective GME locus and an upward (downward) shift of the LME locus. A trade surplus leads to more wealth, which when there is unemployment increases the effective demand of households for goods and thus

chokes off some of the trade surplus. When firms are rationed, the increase in wealth reduces the supply of labour and thus of goods, increases the demand for goods, and thus chokes off the trade surplus in two ways. However, in the latter case the initial excess demand for labour is worsened. These adjustment processes are of course related to David Hume's specie-flow mechanism and the monetary approach to the balance of payments.

The adjustment process under floating exchange rates is quite different. When there is an incipient trade surplus, the nominal exchange appreciates, the home price level falls and thus real wealth is boosted. This chokes off the excess supply of goods, so that the economy never diverges from the effective GME locus and balanced trade.

A fiscal expansion in an economy with fixed exchange rates shifts the Walrasian equilibrium from W to W' , so that on impact the trade deficit rises by exactly the same amount as the increase in government spending (cf., the New Cambridge School). As the budget deficit must be financed by money creation, next period's stock of real money balances increases by the change in government spending. However, this increase is exactly off-set by the decrease due to the ensuing trade deficit and thus there is no change in the short-run equilibrium over time. Effectively, the government uses its foreign reserves to purchase commodities from abroad as can be seen from the identity

$$(m - m_0) + (\pi - \pi_0) = g + b, \quad (17)$$

i.e., the net acquisition of financial assets by the private sector must equal the sum of the government deficit and the trade surplus.

With floating exchange rates and real wage rigidity the new Walrasian equilibrium lies to the north-east of W' , say W'' , so that the fiscal expansion leads to unemployment. The reason for this (counter-intuitive) result is that the depreciation of the exchange rate, required to choke off the incipient trade deficit, increases the home price level, erodes real wealth and increases the supply of labour (whilst the real wage and thus labour demand are unaffected).

Note that a devaluation in a situation of unemployment erodes the real value of wealth and therefore reduces the demand for goods and cases

a trade surplus. (If there is nominal rather than real wage rigidity, labour demand and output increase.) A devaluation in a situation of excess demand for labour reduces labour supply and output, decreases demand and improves the trade balance.

Static two-country models with imperfect substitution between home and foreign goods are analyzed in Lorie and Sheen (1982), Laussell and Montet (1983), and Owen (1985), whilst dynamic two-country models with a single homogeneous internationally traded good (i.e., with purchasing power parity) are analyzed in Persson (1982) and in Rankin (1987b). Purchasing power parity is not a very realistic assumption. A static model is not very realistic either, because a satisfactory description of floating exchange rates requires a dynamic model of the capital account and the demand for bonds as well as for money. Hence, future work will analyze dynamic two-country models of rationing with differentiated products.

3.2. A two-sector model: Traded and non-traded goods

The two-sector model developed by Neary (1980) extends Dixit (1978) by allowing for a non-traded good whose price is rigid in the short run. It basically introduces rationing of the non-traded goods and labour markets into Salter's (1959) well-known model of the dependent economy. The dependent economy model has a fixed exchange rate (E) and produces a traded good (s_T), which is a perfect substitute for the foreign good ($P_T^* = P^* E$ where P_T denotes the home price of the traded good), and a non-traded good (s_N) with price P_N . Labour is mobile between the two sectors, but not internationally. Production in each of the two sectors obeys neoclassical production functions, $s_i = f_i(l_i)$, $i = N, T$ where l_i is employment in sector i . Maximization of profits under perfect competition in each sector yields the notional labour demand functions $l_i^d = L_i^d(w_i)$, $i = N, T$, where $w_N = W/P_N$ is the real wage faced by producers of non-traded goods, $w_T = W/P_T = w_N/e$ is the real wage faced by producers of traded goods, W is the nominal wage, and $e = P_T/P_N$ is the real exchange rate. For simplicity, we assume that the supply of labour is inelastic ($l^s = \bar{l}$). In that case, labour market equilibrium yields

$$\bar{l} = L_N^d(w_N) + L_T^d(w_N/e) \quad (18)$$

so that

$$w_N = W_N(e), \quad W'_N = w_T/[1 + (e f'_T/f'_N)] > 0. \quad (18')$$

The LME locus (see Figure 4) slopes upwards, because an increase in the relative price of traded goods (e) induces a shift along the production possibility frontier and therefore resources (i.e., labour) are moved from the non-traded to the traded goods sector. Households maximize their utility, $U(c_T, c_N, m)$ where c_i is consumption of good i and $m = M/P_N$ denotes real money balances, subject to their budget constraint, $e c_T + c_N + m = \pi_0 + w_N l + m_0$. The notional demand functions are:

$$c_T^d = C_T^d(e, m_0 + \pi_0 + w_N l) = \beta_1 (m_0 + \pi_0 + w_N l) / e \quad (19)$$

$$c_N^d = C_N^d(e, m_0 + \pi_0 + w_N l) = \beta_2 (m_0 + \pi_0 + w_N l) \quad (20)$$

$$m^d = M^d(e, m_0 + \pi_0 + w_N l) = \beta_3 (m_0 + \pi_0 + w_N l), \quad (21)$$

where the explicit solutions are given for the case of Cobb-Douglas preferences, $U(.) = \beta_1 \log(c_T) + \beta_2 \log(c_N) + \beta_3 \log(m)$, $\beta_i \geq 0$, $\beta_1 + \beta_2 + \beta_3 = 1$. It follows that equilibrium in the market for non-traded goods (NTGME) is given by

$$f_N(L_N^d(w_N)) = C_N^d(e, m_0 + \pi_0 + w_N l) + g_N, \quad (22)$$

where g_N is real government spending on non-traded goods. If non-traded goods are a gross substitute ($C_{N,e}^d > 0$), an appreciation of the real exchange rate increases the demand for non-traded goods which needs to be choked off by a fall in the real wage as this increases supply, and reduces income and demand. Hence, the NTGME locus slopes downwards when non-traded goods are a gross substitute. The Walrasian equilibrium, W , is at the intersection of the notional LME and NTGME loci. The two loci divide the space into four zones of economic misery. An increase in government spending on non-traded goods exerts an upward pressure on the relative price of non-traded goods. This increases the wage faced by producers of

traded goods and reduces the demand for labour in the traded sector; the incipient excess supply of labour is choked off by a fall in the real wage faced by producers of non-traded goods and an increase in employment in the non-traded sector. The decrease in the supply of traded goods (s_T) and the increase in the demand for traded goods (c_T) induces a trade deficit as can be seen from:

$$b = f_T(L_T^d(w_N/e)) - C_T^d(e, m_0 + \pi_0 + w_N l) - g_T \quad (23)$$

where g_T is government spending on traded goods. The TGME locus is the locus of balanced trade; below (above) it there is a trade deficit (surplus). It slopes upwards because an increase in the relative price of traded goods leads to an excess supply of traded goods that needs to be choked off by an increase in the wage facing producers of non-traded goods. Under floating exchange rates this deficit is choked off by a depreciation of the nominal exchange rate (fall in e), but under fixed exchange rates the adjustment occurs via changes in the level of foreign reserves, money and wealth.

So far, we have considered the notional demands and supplies and the Walrasian equilibrium. However, when prices and wages are not flexible, they may not be at their Walrasian levels and therefore there will be at least one type of agent that is constrained in the non-traded goods market and one type of agent that is constrained in the labour market.

When there is involuntary unemployment, the effective demand for non-traded goods is lower and thus its relative price must fall to ensure equilibrium in the market for non-traded goods (NTGME). Hence, the NTGME:XSL locus,

$$f_N(L_N^d(w_N)) = \tilde{C}_N^d(e, m_0 + \pi_0 + w_N [L_N^d(w_N) + L_T^d(w_N/e)]) + g_N \quad (24)$$

lies to the right of the NTGME locus (see Figure 5). When there is excess demand for labour, firms in either the traded or in the non-traded sector or in both sectors are rationed. If firms in the traded sector get priority in the allocation of labour, the NTGME:XDL locus is given by

$$f_N(\lambda - L_T^d(w_N/e)) = C_N^d(e, m_0 + \pi_0 + w_N \lambda) + g_N. \quad (25)$$

Since the supply of non-traded goods is rationed, the relative price of non-traded goods must rise and therefore the associated NTGME:XDL* locus lies below the NTGME locus. If firms in the non-traded sector get priority in the allocation of labour, the associated NTGME:XDL** coincides with the NTGME locus. When there is an excess demand for non-traded goods (XDNT), firms in the non-traded sector are not rationed and therefore the LME:XDNT locus coincides with the LME locus. When there is an excess supply of non-traded goods (XSNT), firms in the non-traded sector are rationed by the demand for their products so that the LME:XSNT locus is given by

$$\lambda = L_T^d(w_N/e) + f_N^{-1}(C_N^d(e, m_0 + \pi_0 + w_N \lambda) + g). \quad (25')$$

Note that the LME:XSNT locus is identical to the NTGME:XDL locus. Figure 5 portrays the four possible regimes familiar from the analysis of the closed economy (see Section 2). Classical unemployment (CU) prevails when there is XSL and XDNT, Keynesian unemployment (KU) when there is XSL and XSNT, and repressed inflation (RI) when there is XDL and XDNT, and underconsumption (UC) when there is XDL and XSNT. The underconsumption regime is degenerate when firms in the traded sector get priority in the allocation of labour. However, when firms in the non-traded sector have priority, double rationing of firms and therefore underconsumption is a possibility. This possibility is not due to inventories (as in Section 2) but arises because firms producing traded goods are rationed in their demand for labour whilst firms producing non-traded goods are rationed in their sales of goods.

More details on the duality approach to rationing models of open economies may be found in Dixit and Norman (1980). Gunning (1983) and Kennally (1983) also discuss interesting models of rationing in open economies. Excellent surveys of disequilibrium macroeconomics in open economies are Cuddington, Johansson and Lofgren (1984) and Neary (1986).

3.3. The effects of an oil bonanza

To illustrate the dependent economy model, it is probably best to discuss a policy application. One of the more interesting ones is the problem of the "Dutch Disease". This occurs when a small open economy discovers natural resources, say oil (or natural gas), and consequently experiences an oil bonanza. It is assumed that no use is made of capital or labour in the production of oil, so that it is similar to the shock that occurs when a small open economy receives a transfer of foreign aid. The result is an increase in private wealth, which in a Walrasian world shifts the equilibrium from W to W' (see Figure 4). The oil bonanza leads to an increase in income, so that the demand for non-traded goods rises. To choke off this extra demand, the relative price of non-traded goods increases, i.e., the real exchange rate appreciates, and therefore resources move from the traded sector to the non-traded goods sector. This is accompanied by a fall in the real wage prevalent in the non-traded goods sector and, due to the appreciation of the real exchange rate, an increase in the real wage of the traded goods sector, $w_T = w_N/e$. The decline in employment and output of the traded sector is called the "Dutch Disease". Obviously, there is a worsening of the non-oil trade balance as the supply of traded goods has fallen and the demand for traded goods has increased. This decline of the traded goods sector is not necessarily a reason for policy intervention, since the oil bonanza does not decrease welfare in a Walrasian world.

However, a proper explanation of the "Dutch Disease" requires a disequilibrium analysis (van Wijnbergen, 1984; 1985; Neary and van Wijnbergen, 1986). An explanation is needed of why oil-producing countries such as Egypt, Mexico, United Kingdom and the Netherlands experience problems of unemployment whilst the Gulf countries experience bottlenecks and labour shortages. The reason that the Gulf countries are more likely to slide in to a regime of repressed inflation is that their consumers' price index has a large traded-goods component, so that a rise in the real wage of the sector producing traded goods ($w_T = w_N/e$) allows a large drop in the real wage of the sector producing non-traded goods (w_N) and therefore workers fired in the traded goods sector can more easily be absorbed in to the non-traded goods sector (van Wijnbergen, 1984). For the case that

firms in the traded goods sector get priority in the allocation of labour, the effects of an oil bonanza are presented in Figure 5.

The oil bonanza does not affect the LME:XDNT locus, but shifts down the LME:XSNT locus. The NTGME loci shift down as the additional demand for non-traded goods must be choked off by an increase in the relative price of non-traded goods (i.e., by a real appreciation of the exchange rate). The Walrasian equilibrium consequently shifts from W to W'. It follows that at the pre-bonanza equilibrium, W, there will now be an excess demand for non-traded goods and labour market equilibrium. Where the economy will move to from there depends on the wage-price adjustment one assumes. Van Wijnbergen (1984) assumes that the relative price of non-traded goods rises when there is an excess demand for non-traded goods,

$$\hat{P}_N - \hat{P}_T = -\hat{e} = \lambda_N \left[c_N^d + g_N - f_N(\lambda_N^d) \right], \lambda_N \geq 0, \quad (26)$$

and that the real consumers' wage declines when there is unemployment,

$$\hat{W} - (1-\psi)\hat{P}_N - \psi\hat{P}_T = \lambda_L (\lambda_T^d + \lambda_N^d - \lambda), \lambda_L \geq 0 \quad (27)$$

where $0 \leq \psi \leq 1$ denotes the share of traded goods in the basket of consumers' goods. The wage adjustment implies that there is full indexation to increases in the cost of living. At the pre-bonanza equilibrium, there is LME and XDNT and consequently the real wage in the non-traded goods sector is decreasing, due to indexation to falling relative prices of traded goods ($\hat{w}_N = \psi\hat{e} = -\psi\lambda_N XDNT < 0$), and the real wage in the traded goods sector is increasing ($\hat{w}_T = \hat{w}_N - \hat{e} = (1-\psi)\lambda_N XDNT > 0$). Since $\hat{w}_N = -\psi(1-\psi)^{-1}\hat{w}_T < 0$, one sees that, when the share of traded goods in the consumers' basket, ψ , is high, a rise in w_T allows a large drop in w_N . This means that workers sacked in the traded goods sector can be more easily taken on by the non-traded goods sector, so that excess demand for labour and repressed inflation is more likely to occur (as in the move from W to R in Figure 5). Since the Gulf countries have a large share of traded goods in their consumers' basket, they are more likely to end up with repressed inflation and therefore to import labour from abroad. Countries such as Egypt, Mexico and Indonesia have, due to various import barriers, a low share of traded goods and therefore they are more likely

to end up in a regime of classical unemployment (as in the move from W to C in Figure 5). If the traded and non-traded goods sectors employ the same CES technologies, it can be shown that the economy slides into repressed inflation (classical unemployment) when the share of traded goods in the basket of consumers' goods, ψ , exceeds (is less than) the proportion of traded goods in total production. Alternatively, countries with a non-oil deficit (surplus) end up with repressed inflation (classical unemployment). Note that only short-run effects of an oil bonanza have been considered; in the long run wage and price adjustment ensure that repressed inflation or classical unemployment disappear. In the long run one has an increase in the relative price of non-traded goods, a decline of the traded sector, and a boom of the non-traded sector. It may be a long and painful process to achieve the new long-run equilibrium, hence in the short run there may be a role for government policy.

For those countries that end up with repressed inflation, import of labour may be a sensible policy. This shifts up the LME:XSNT' and LME:XDNT loci and therefore reduces the required real appreciation of the exchange rate. The intuition is that the extra workers employed in the non-traded goods sector spent only part of their total expenditure on non-traded goods. Hence, the excess demand for non-traded goods and the associated inflation will be less. For those countries that end up with classical unemployment, wage subsidies to the traded goods sector may be a sensible policy. If $w_T = w_N/e$ is pegged at the pre-oil level, no workers are fired in the traded goods sector and classical unemployment is ruled out. Since the real appreciation now only works on the demand side and no resources are shifted from the traded goods sector, the real appreciation has to be larger. A more effective policy is to cut the wedge between the real consumers' and real producers' wage (for example, with a cut in the indirect tax rate), since this cuts labour costs across the board.

4. Constraint expectations in dynamic economies

4.1. Micro foundations of a two-period macroeconomic model

Another interesting extension of the static Barro-Grossman-Malinvaud analysis of rationing in a closed economy (see Section 2) is to allow for intertemporal considerations. This shows the role of expectations, which is crucial in Keynesian theory. The simplest theory is based on the two-period model developed by Neary and Stiglitz (1983). This allows one to consider intertemporal spill-over effects, that is expectations of future quantity constraints will affect the current regime. In particular, it can be shown that, when agents expect unemployment tomorrow, it will be more likely that there is unemployment today. So pessimistic expectations can lead to bad outcomes today (cf., Persson and Svensson, 1983); such phenomena are referred to as "boot-strap" effects. When expectations about future quantity constraints are rational, it can be shown that this increases the Keynesian employment multiplier: the fiscal expansion today also raises national income, aggregate demand and the demand for labour tomorrow and therefore current savings falls and current aggregate demand rises more than it would do otherwise.

Let us start with a brief description of a simplified version of the model developed by Neary and Stiglitz (1983). Households have an inelastic supply of labour, $l = \bar{l}$, and decide on their life-time consumption plan on the basis of subjective point expectations about future wages, prices and constraint levels. To keep matters simple, only the first two periods are concerned. Hence, households maximize their utility function, say $U(c_1, c_2, m_2) = \alpha_1 \log(c_1) + \alpha_2 \log(c_2) + \alpha_3 \log(m_2)$, $\alpha_i \geq 0$, $\alpha_1 + \alpha_2 + \alpha_3 = 1$ where c_i denotes consumption of goods in period i and $m_2 = M_2/P_2$ denotes real money holdings at the end of the second period, subject to their intertemporal budget constraint, $P_1 c_1 + P_2 c_2 + M_2 \leq Y = M_0 + P_1 s_1 + P_2 s_2$ where Y denotes total income, M_0 denotes the households' initial endowment of money balances and s_i denotes the households' real income in period i . The indirect utility from consumption beyond the first two periods is captured by the fact that m_2 enters $U(\cdot)$; obviously, $U(\cdot)$ also depend on exogeneous expectations of prices, wages and constraint levels in periods beyond the first two. Note that in contrast to Section 2, profits are

assumed to be distributed instantaneously. The maximization yields the notional demand functions for current and future consumption:

$$c_1^d = C_1^d(P_1, P_2, Y) = \alpha_1 Y/P_1 \quad (28)$$

$$c_2^d = C_2^d(P_1, P_2, Y) = \alpha_2 Y/P_2 \quad (29)$$

where C_i^d is homogeneous of degree zero in its arguments. Consumption in each period is a normal good and thus responds negatively to the price prevailing in that period. If the substitution (income) effect dominates, consumption today depends positively (negatively) on the price tomorrow. For Cobb-Douglas preferences, the income and substitution effects exactly cancel out. The notional demand for money is clearly given by $m_2^d = M_2^d(P_1, P_2, Y) = \alpha_3 Y/P_2$.

Firms maximize discounted profits,

$$\pi = P_1 f(l_1) - w_1 l_1 + P_2 f(l_2) - w_2 l_2,$$

which leads to the notional labour demand functions,

$$l_i^d = L^d(w_i), \quad L^{d'} = 1/f'' < 0, \quad i = 1, 2, \quad (30)$$

where $w_i = W_i/P_i$ denotes the real wage in period i , and notional output supply functions,

$$s_i^s = f(L^d(w_i)) = S^s(w_i), \quad S^{s'} = f' L^{d'} < 0, \quad i = 1, 2. \quad (31)$$

Note that we have ignored the role of inventories.

The government can purchase goods in each period, g_i , and can make transfer payments to households, thereby increasing their initial endowment, M_0 , and finances these policy actions by printing money.

4.2. Notional and effective equilibria with Walrasian expectations

Consider first the case where agents do not expect to be constrained, either today or tomorrow. This leads to the notional GMEi locus of period i,

$$S^s(w_i) = C_i^d(P_1, P_2, M_0 + P_1 f(\lambda) + P_2 f(\lambda)) + g_i, \quad (32)$$

and the notional LMEi locus of period i,

$$\lambda = L^d(w_i). \quad (33)$$

To reduce the dimensionality of the economy, assume that P_1 and w_2 remain always at their Walrasian levels and concentrate on variations in w_1 and P_2 only. Hence, concentrate on the two first-period loci only (see Figure 6). The LME1 locus is horizontal with points above (below) it corresponding to excess supply of (demand for) labour. The GME1 locus is downward-sloping, because an increase in today's real wage reduces aggregate supply and a reduction in tomorrow's price level reduces total income and therefore reduces aggregate demand. (If the substitution effect dominates, aggregate demand falls even further.) Points above (below) the GME1 locus correspond to excess demand for (supply of) goods.

Now consider the case where agents expect Walrasian equilibrium to prevail tomorrow yet allow for the possibility of quantity constraints today. This leads to the same type of spill-over effects discussed in Section 2. When there is unemployment today, households' effective demand for goods will be less than their notional demand and therefore to maintain goods market equilibrium today's real wage has to rise. This is the reason why the GME1:XSL1 locus,

$$S^s(w_1) = C_1^d(P_1, P_2, M_0 + P_1 f(L^d(w_1)) + P_2 f(\lambda)) + g_1, \quad (34)$$

is steeper than the GME1 locus (see Figure 6). When there is an excess demand for labour today, the GME1:XDL1 locus is given by

$$f(\lambda) = C_1^d(P_1, P_2, M_0 + P_1 f(\lambda) + P_2 f(\lambda)) + g_1 \quad (35)$$

and is therefore vertical. Firms are constrained in their hiring of labour and therefore their effective supply of goods is less than their notional supply. It follows that tomorrow's price level has to fall in order to ensure goods market equilibrium today. If there is an excess supply of goods today, firms' demand for labour is constrained by the demand for goods and therefore the LME1:XSG1 locus coincides with the GME1:XDL1 locus. This obviously rules out the regime of underconsumption, which is due to the fact that there are no inventories. Obviously, the LME1:XDG1 locus coincides with the LME1 locus as the supply of labour is inelastic. The resulting effective GME1 and LME1 loci divide the space up in to three regimes, i.e., Keynesian unemployment, classical unemployment and repressed inflation (see Figure 6), so that as long as expectations about the future are Walrasian the analysis is analogous to the standard Barro-Grossman-Malinvand analysis.

4.3. Intertemporal spill-over and "boot-strap" effects

Now consider intertemporal spill-over effects, that is the effects of expectations of future quantity constraints on current behaviour of households and firms. One of the objectives of Neary and Stiglitz (1983) was to demonstrate the existence of "boot-strap" phenomena; when households expect to be unemployed today, and when firms expect they cannot sell all their goods tomorrow, it is also more likely that firms will be unable to sell all their goods today. Such phenomena leads to the possibility of multiple equilibria for a given level of current and expected future wages and prices. For ease of exposition, we concentrate on the effects of expected Keynesian unemployment or classical unemployment.

Since the supply of labour is inelastic, the effective LME1 locus coincides with the notional LME1 locus as long as firms face no quantity constraints in the current period. When households expect to be constrained in their sale of labour tomorrow, their human wealth declines and therefore current consumption falls. It follows that the GME1:XSL2 locus,

$$S^S(w_1) = C_1^d(P_1, P_2, M_0 + P_1 f(\lambda) + P_2 f(L^d(w_2/P_2))) + g_1, \quad (36)$$

lies to right of the notional GME1 locus, so that a higher current real wage chokes off supply to the lower level of demand. (Obviously, the GME1:XDL2 locus coincides with the GME1 locus but we are not interested in this locus anyway.) When firms expect to be unable to sell all their goods tomorrow, this does not affect the current effective supply of goods as we abstract from the intertemporal spill-over effects arising from (reduced) inventories. This means that the GME1:KU2 (or GME1:XSL2,XSG2) locus coincides with the GME1:XSL2 locus. However, if households expect that tomorrow there will be an excess demand for goods as well as an excess supply of labour (expect classical unemployment), then there is less incentive for households to save (as they cannot buy all the goods they want tomorrow anyway) and therefore current consumption increases. This means that the current real wage has to fall in order to boost supply, which shifts the GME1:CU2 locus,

$$S^S(w_1) = \tilde{C}_1^d(P_1, P_2, M_0 + P_1 f(\bar{L}) + P_2 f(L^d(w_2/P_2)), \bar{c}_2) + g_1 \quad (37)$$

where $\tilde{C}_1^d(\cdot)$ denotes the demand-for-current-consumption function when tomorrow's demand for goods is constrained to $\bar{c}_2$, to the left and thereby expands the region of current excess demand for output. The GME1:CU2 locus is only relevant for those P_2 for which there is an excess demand for goods tomorrow:

$$C_2^d(P_1, P_2, M_0 + P_1 f(\bar{L}) + P_2 f(L^d(w_2/P_2))) > \bar{c}_2 \quad (38)$$

say for $P_2 < P_2^H(\bar{c}_2)$ where $P_2^H(\cdot)$ denotes the threshold level for P_2 . For $P_2 > P_2^H(\cdot)$ the GME1:CU2 locus coincides with the GME1:XSL2 locus. Since future consumption is constrained, $P_2^H(\cdot)$ lies to the right of the Walrasian level, P_2^* . The above results are illustrated in Figure 7.

So far, we have looked at the notional first-period loci when there are expectations of future quantity constraints. Now consider the effective loci when there are expectations of either Keynesian unemployment or classical unemployment (also, see Figure 7). The effective GME1:XSL1,KU2 locus is given by

$$S^S(w_1) = C_1^d(P_1, P_2, M_0 + P_1 f(L^d(w_1)) + P_2 f(L^d(w_2/P_2))) + g_1 \quad (39)$$

whilst the effective GME1:XSL1,CU2 locus is given by

$$S^S(w_1) = \tilde{C}_1^d(P_1, P_2, M_0 + P_1 f(L^d(w_1)) + P_2 f(L^d(w_2/P_2)), \bar{c}_2) + g_1. \quad (40)$$

These two loci are only relevant above the LME1 locus, that is when there is unemployment today. Obviously, they pivot to the right as current unemployment means that today's demand for goods will be less and therefore the supply of goods needs to be choked off with a higher real wage in order to maintain goods market equilibrium in the first period. Clearly, the GME1:XL1,KU2 locus lies completely to the right of the GME1:XL1,CU2 locus. It is now possible to divide the w_1 - P_1 space bordered by the LME1, GME1:XSL1,CU2 and GME1:XSL1,KU2 loci into combinations of current and expected future regimes (see Figure 7). The shaded region is the most interesting one; it consists of either (KU1,KU2) or (CU1,CU2).

The first point to notice is that the vector of current and expected future wages and prices consistent with Walrasian equilibrium is not unique (any P_2 in between P_2^* and P_2^H , for example), since it depends on the nature of expectations about future quantity constraints. The second point to notice is the non-uniqueness of effective equilibria for particular constellations of current and expected future wages and prices; the shaded region of Figure 7 is compatible with either Keynesian or classical unemployment today, depending on what agents expect tomorrow. The final point to notice is the "boot-strap" effect, that is Keynesian (classical) unemployment is more likely to occur today when it is expected to prevail tomorrow.

Of course, it is possible to extend the analysis in order to allow for the effects of different constraint expectations.

4.4. Rational constraint expectations

The previous section employed arbitrary expectations about future quantity constraints, which is undoubtedly the main reason for the non-uniqueness of the Walrasian and effective equilibria. In order to avoid this problem, one might borrow the assumption of rational expectations from the New Classical School of Macroeconomics. Although the assumption of rational expectations may be within the spirit of market clearing and

other assumptions of the New Classical School, it is a rather far-fetched assumption within a macroeconomic model with rationing. The assumption of rational constraint expectations presumes that agents have an enormous amount of information in order to be able to calculate the aggregate future quantity constraints in a rational fashion. However, it does not require knowledge of individual demands and supplies. This is just as well, since if this were the case firms and households could engage in bilateral bargaining which contradicts the fundamental assumption of fixed wages and prices. Due to the difficulties in the coordination of the behaviour of individual households and firms when information (at a disaggregated level) is imperfect, the assumption of rational constraint expectations may be a first step in removing the arbitrariness of expectations.

To understand rational constraint expectations, let us focus on the case where there is unemployment today and Keynesian unemployment is expected tomorrow. It is important at this stage to distinguish between real and nominal wage rigidity. If there is real wage rigidity (w_2 constant), then the GME1:XSL1,KU2 locus is also the locus that pertains under rational constraint expectations. However, if there is nominal wage rigidity (i.e., W_2 constant), one has to take account of the fact that second-period income, $s_2 = f(L^d(w_2/P_2))$, is an increasing function of the second-period price, since a higher price erodes the real wage and this boosts labour demand, employment and income. This means that the locus under rational constraint expectations, say the RCE locus, lies to the right of the GME1:XSL1 locus. (Neary and Stiglitz (1983) discuss an iterative procedure to obtain consistency of expectations and of actual outcomes, which demonstrates that this remains the case even when there are intertemporal spill-over effects arising from inventories.)

The main implication of the above argument is that the set of w_1 - P_2 combinations consistent with Keynesian rather than classical unemployment today is greater when Keynesian unemployment rather than when Walrasian equilibrium is expected to prevail tomorrow, so that rational constraint expectations increases the likelihood of Keynesian unemployment today. Hence, the "boot-strap" property still holds when constraint expectations are rational. The assumption of rational constraint expectations also reduces the non-uniqueness of the set of equilibria.

Neary and Stiglitz (1983) also show that, under the assumption of rational constraint expectations, the effects of an increase in government spending on employment and output during a Keynesian regime today is greater than under static expectations of Keynesian unemployment tomorrow and greater still than under Walrasian expectations about the future. The main reason for this interesting result is that an increase in government spending is more effective when firms are pessimistic about their future sales prospects. Also, the increase in government spending relaxes the constraint on current sales and therefore firms might plan to hire more labour and produce more output tomorrow. Under the assumption of rational constraint expectations, households realize that this increases their life-cycle income and therefore increase consumption both today and tomorrow which in turn increases the effective demand for labour today.

Note the sharp contrast with the policy neutrality results of the New Classical School. Their neutrality results depend on price flexibility (market clearing) and rational expectations. Rational expectations actually enhance the effectiveness of fiscal policy in the rationing approach. Hence, it follows that the essential ingredient of the policy neutrality propositions of the New Classical School is market clearing rather than rational expectations. In this sense, the great debates about the effectiveness of aggregate demand management that took place in the recession of the thirties seem to be repeated forty to fifty years later with the "icing on the cake" being rational expectations.

5. Concluding remarks

This paper presented a survey of rationing in simple macroeconomic models. It started off with rationing in a closed economy. The main point was to distinguish between effective and notional demands and supplies, where the former takes account of the spill-over effects of rationing in other markets. For example, a household who cannot sell all the labour it wants, will consume less. Because allowance was made for the buffer role of real money balances and inventories, the four regimes of Keynesian unemployment, classical unemployment, underconsumption and repressed inflation could be distinguished. The effectiveness of fiscal and monetary policy in each of these four regimes was analyzed. Neither policy has any effect when there is classical unemployment. A fiscal or monetary expansion increases employment and output when there is Keynesian unemployment (or underconsumption), but decreases employment and output when there is repressed inflation. There was also a discussion of wage price dynamics.

The paper continued with a consideration of rationing in a one-sector small open economy. There cannot be any disequilibrium in the goods market, because any excess demand for (supply of) goods is eliminated by importing from (exporting to) the rest of the world. The result is a "Mundell-Swan" diagram with four regimes: unemployment and trade deficit or trade surplus and excess demand for labour and trade deficit or surplus. A two-sector small open economy, with a traded ("exposed") goods sector and a non-traded ("sheltered") goods sector was considered next. The traded goods market always clears, because any excess demand or supply can be met from abroad. It follows that the four regimes of Keynesian unemployment, classical unemployment, repressed inflation and underconsumption reappear (even if there are no inventories). It was assumed that the relative price of non-traded goods rises when there is an excess demand for non-traded goods and that the real consumers' wage declines when there is unemployment. The effects of an oil bonanza in such a two-sector economy depends on the share of imported goods in the consumers' basket. When this share is large the economy slides into a regime of repressed inflation and when it is small the economy end up in a regime of classical unemployment. The former case corresponds to the Gulf countries and the latter case corresponds to the Latin American countries.

The survey ended up with a discussion of rationing in dynamic, closed economies. In such a setting the effects of expectations about future constraints on current regimes need to be considered. What one finds is that households' (firms') expectations of future constraints on their ability to sell labour (goods) make it more likely that they face a sales constraint in the current period. This phenomenon is referred to as "boot-strap" equilibria. When one allows for rational constraint expectations in a current regime of Keynesian unemployment, one finds that the employment multiplier of government spending is greater with rational than with static expectations of Keynesian unemployment. Hence, one finds that in a disequilibrium setting rational expectations can reinforce the Keynesian multiplier.

No survey is complete without giving an indication of what the promising areas for further research are. At least three areas can be pinpointed. The first area is to use existing macroeconomic models with rationing for policy purposes. These models are ideally suited for such tasks, because the micro foundations mean that a proper welfare analysis is feasible. To do this in a convenient way requires the use of duality (revenue and expenditure functions), because then the effects of policy changes on utility levels can immediately be deduced (e.g., Dixit and Norman, 1980; but also see Neary and Roberts, 1980 for the use of "virtual prices" in duality analysis). Good examples of such policy exercises are van Wijnbergen (1984, 1985) on the effects of an oil bonanza and the "Dutch Disease" and Rankin (1987a) on the welfare-maximizing levels of government spending, taxation and debt in a dynamic, closed economy with rationing. The two-country model with rationing developed in Rankin (1987b) can fruitfully be applied to analyse the merits of international policy coordination, especially when one assumes nominal wage rigidity in the U.S. and real wage rigidity in Europe. This might provide an explanation of why, in the absence of international policy coordination, fiscal policy is too loose in the U.S. and too tight in Europe. The second area for further research is to relax the assumption of price and wage stickiness or, alternatively, to explain why these rigidities occur (see Drazen, 1980). An interesting example of this is Gale (1983), who develops a competitive model that operates not too differently from a fix-price rationing model. Gale's competitive model has Keynesian features, because it

allows firms to be liquidity constrained when prices are unexpectedly low. Hart (1982) and Bénassy (1986) give alternative explanations based on monopolistic competition. A related problem is that future research should explain unemployment rather than underemployment (cf., Lucas, 1987). A 10% reduction in working hours (increase in leisure) for 100% of the labour force is what might happen in rationing models, but is quite different from a 100% reduction in workers hours for 10% of the labour force and therefore requires a very different policy response. In other words, future work should model unemployment as an activity and model the specific relationship between the individual worker and firm. Useful steps in this direction have already been made by the theory on search and job matching (see the survey in Lucas, 1987). The third area for further research is to develop and use econometric methods to test macroeconomic models of rationing. Fundamental empirical work on (non-linear simultaneous, dynamic and trade) rationing models of the Dutch economy has been reported in Siebrand (1979). Rigorous estimation procedures are discussed in Sneessens (1981), Kooiman and Kloeck (1982) and Kooiman (1984) whilst a more eclectic approach is used to estimate a rationing model of the Belgian economy in Sneessens and Drèze (1986).

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Figure 1: Effects of fiscal expansion on a Walrasian equilibrium

Figure 2: Effective GME and LME loci and the four regimes

Figure 3: Rationing in a one-sector model of a small open economy

Figure 4: Market clearing in the dependent economy

Figure 5: Rationing in the dependent economy

Figure 6: Effective equilibria with Walrasian expectations about the future

Figure 7: Effective equilibria with expectations of future Keynesian or classical unemployment

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